METHOD FOR JOINING EXCITATION POLES OF POLE HOUSING, AND ELECTRICAL MACHINE PRODUCED THEREBY

Background of the Invention

~~Prior Art~~

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~~The invention relates to method for producing a~~ joining connection, in particular between excitation poles and the pole housing of an electrical machine, having the characteristics recited in the preamble to claim 1, ~~as~~ well as to an electrical machine produced ~~thereby.~~

In electrical machines that have an electrical excitation, it is known for the excitation poles that carry the exciter winding to be secured to the inside of a substantially cylindrical pole housing. The securing can be done in a known manner, for instance by means of a welded or adhesive connection or bond. Furthermore, from French Patent Disclosure FR 2488749, a method is known in which excitation poles are secured by stamping dies by means of a nonpositive and positive joining connection, and material of the pole housing is positively displaced into a conical recess of the excitation poles. A disadvantage of this is the high expense for tools and the requisite high precision in aligning the joining tools with the recess. From German Patent DE 2435574, a riveting method is known in which a cylindrical rivet shank is formed by being pressed out of a region of an excitation pole in such a way that the rivet shank is perpendicular to the surface that rests on the inside of the pole housing once the excitation pole has been secured; the rivet shank is inserted through a hole that is cylindrically countersunk on the

outside of the pole housing, and finally is deformed in such a way that the deformed rivet shank is located entirely inside the countersunk hole. From French Patent FR 2 530 387, a method with a similarly formed rivet shank of an excitation pole is known, in which the rivet shank is inserted from inside through a hole in the pole housing that is countersunk conically from outside; the rivet shank is widened from outside, by positive displacement of material from the axial center of the rivet shank, in such a way that a closing head for positive and nonpositive connection to the pole housing is created in the conical countersunk hole. From German Patent Disclosure DE-OS 19538483, a method is known in which a joining force is exerted by a joining tool on a joining location located on the outside of a pole housing, and as a result, material from the pole housing is positively displaced into a recess of the excitation poles. This creates a positive and nonpositive connection between the pole housing and the excitation pole.

The rivet connections from German Patent DE 2435574 and French Patent FR 2 530 387 both have the disadvantage that a rivet pin must be formed out of the excitation pole by considerable expenditure of labor; the joining forces are strong; and finally, the machining effort is increased because of the countersinking that follows the perforating of the pole housing. The disadvantages of the method known from DE-OS 19538483 are the high joining forces and the requisite precise alignment of the joining parts.

It is also known to secure the excitation poles to the pole housing using screws with countersunk heads. A

disadvantage of this is the high production cost, which in addition to the perforating of the parts to be joined is determined by thread cutting in the excitation pole and countersinking of the pole housing.

Summary of the Invention

~~Advantages of the Invention~~

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~~With the method according to the invention as~~ defined by the characteristics of the body ~~of~~ claim 1, it is possible to create a positive and nonpositive connection between the excitation poles and the pole housing in a simple way compared to the prior art. Because the pole housing is secured to the excitation poles by means of separate rivets, a positive and nonpositive connection is obtained in spot fashion at at least one joining location. Furthermore, this connection is achieved by means of simple method steps ~~and a simple tool.~~

The production cost for the stator comprising the pole housing and the excitation poles can be reduced sharply. The pole housing and the excitation poles need to be perforated only at least once each per excitation pole and then riveted at least once per excitation pole; the parts to be joined are aligned with one another by the insertion of the rivets.

Further advantages are considered to be that the absorption of strong forces at the work apparatus and at the excitation poles, of the kind that have to be absorbed in the nonpositive and positive joining connections of the three references cited above, is dispensed with. Since this involves a connection that

can be undone by drilling it open, all the components except the rivet are re-usable. Compared with the known securing of the excitation poles with screws, thread cutting in the pole core and deep countersinking in the pole housing, the screw itself, and the counterbracing moment when the screws are tightened are all omitted. All that is required is an axial alignment and placement of the excitation pole against the pole housing.

Advantageous refinements of and improvements to the characteristics recited in the main claim are obtained by the characteristics recited in the dependent claims.

Drawings

The invention will be described in further detail in terms of exemplary embodiments in conjunction with the associated drawings. Figs. 1a and 1b show a schematic sectional view through a joining connection by means of a blind rivet between an excitation pole and a pole housing, before and after the joining; Figs. 2a-2d are sectional views of a plurality of variants of an excitation pole for a joining connection by means of a blind rivet.

Description of the Exemplary Embodiment

Figs. 1a and 1b in fragmentary sectional form show a pole housing 10 and an excitation pole 11 of a stator 12 of an electrodynamic machine, which is not shown in its entirety. As a rule, the electrodynamic machine has four or six excitation poles 11, which are disposed over the inside circumference of the cylindrical pole housing

10. The method for producing a joining connection between the pole housing 10 and the excitation poles 11 will be explained in terms of the fragmentary view of an excitation pole 11. A rivet 13 with a conventionally premounted rivet pin 14 is first, as shown in Fig. 1a, inserted from outside with its rivet shank 15 through a previously drilled or punched hole 16 in the pole housing 10. Next, the excitation pole 11, with its also previously produced hole 17 that is radial to the location of the pole housing 10, is thrust over the rivet shank 15 in such a way that the excitation pole 11 rests flat on the inside of the pole housing 10. If the excitation pole 11 is viewed radially from the outside in terms of its installed position in the pole housing 10, the hole 17 of the excitation pole must have the properties of having a minimum diameter in a first hole segment 18, so that the smooth rivet shank 15 can be inserted therethrough. In a second hole segment 19, coaxially following the first, there must be a region with a larger diameter. This second hole segment 19 must be at least long enough that the rivet 13, inserted into the hole 17, can on the one hand rest flush on the outside of the pole housing 10 with its set-head 20, and on the other, the rivet shank 15 can be reshaped to a closing head 22 by a head 21 of the rivet pin 14; after the joining operation has ended, the closing head is located inside the second hole segment 19. The different diameters of the two hole segments 18 and 19 create an annular narrowing 23 of the hole 17 in the excitation pole 11 that rests directly on the inside of the pole housing 10. The two hole segments 18 and 19 are joined to one another via a step 24. The step 24 can for instance, as shown in Fig. 2a, be embodied as a concentric circular-annular shoulder perpendicular to

the axis of the hole, or as a conical jacket face as in Fig. 2d. In the finished joining connection, the narrowing 23 and the pole housing 10 are clamped between the set-head 20 of the rivet 13 and the closing head 22 of the rivet 13, so that a positive and nonpositive connection between the excitation pole 11 and the pole housing 10 is created. Once the excitation pole 11 has been put into flat contact, it is aligned with the cylinder axis, not shown here, of the cylindrical pole housing 10. An alignment of the excitation pole 11 with the pole housing 10 is attainable for instance by securing the excitation pole 11 by means of two axially offset rivets 13, which automatically align the excitation pole 11 in the correct position relative to the pole housing 10. If there is only one rivet per excitation pole 11, then the alignment must be done before the riveting, using an aid such as a gauge. The thus-concluded preparations are then followed by the actual joining operation.

Once the rivet 13 rests with its set-head 20 on the outside of the pole housing 10, a radially outward-acting joining force F is introduced in an upper end region 25 of the rivet pin 14, for instance by means of blind rivet tongs, not shown here. In this operation, the set-head 20 is braced with its side remote from the outside 26 of the pole housing 10 on a face, not shown here, of the riveting tongs.

The introduction of the force F into the rivet pin 14 leads to a pressing action in the boundary face 27 between the head 21 on the lower end of the rivet pin 14 and the lower end of the rivet shank 15. This pressing action consequently leads in this region to a radially

outward- oriented positive displacement of the material comprising the rivet shank 15 through the head 21 of the rivet pin 14, and thus leads to a widening 28 of the rivet shank 15 in the second hole segment 19 of the hole 17 in the excitation pole 11. In the process, the material comprising the shank flows around the head 21. This widening 28 of the rivet shank 15 forms the closing head 22. The closing head attains an outside diameter that is greater than the smallest diameter of the hole 17 of the excitation pole 11.

As the rivet pin 14 is drawn upward, for the head 21 of the rivet pin 14 that widens the rivet shank 15, the resistance to motion increases as the spacing from the narrowing 23 of the hole 17 decreases, and as a result the radial prestressing of the joining connection of the pole housing 10 and the excitation pole 11 increases through the rivet 13. With effort directed to achieving the narrowest possible joining connection, that is, the smallest possible secondary air gap 29 between the pole housing 10 and the excitation pole 11, the force F introduced into the rivet pin 14 is increased. To assure that the cross section of material between the head 21 of the rivet pin 14 and the step 24 will not be weakened by an excessive force F, a rated breaking point 30 leads to the correctly timed interruption of the flow of force; the rivet pin 14 brakes at its rated breaking point 30. The joining operation ends with this breaking of the rivet pin 14. The rivet 13 presses the pole housing 10 and the excitation pole 11 together between its set-head 20 and its closing head 22 created by the widening. Fig. 1b shows the finished joining connection thus made using a blind rivet 13.

In Figs. 2a-2d, various possible designs for the hole 17 of an excitation pole 11 are shown as examples for the production of a joining connection on the pole housing 10 by blind riveting. Fig. 2a shows a hole 17 of the through type 31, which is attained for instance by a stepped perforation with a reduced diameter, for instance by drilling with a step drill. The step 24 between the larger diameter, on the side of the excitation pole 11 remote from the pole housing 10, and the smaller diameter, on the side toward the pole housing 10, is perpendicular to the axis of the hole. Fig. 2b shows a continuously drilled excitation pole 11, in which the perforating process creates a perforation bead 32, shown in dashed lines, which is subsequently reshaped, by reverse upsetting or pressing down into the narrowing 23 that is required for the joining connection. Fig. 2c shows an excitation pole 11 embodied with a blind bore 33, in which the narrowing 23 is attained as in Fig. 2b. Fig. 2d shows a continuously perforated excitation pole 11, whose hole 17 is attained by metal-cutting machining or reshaping machining or both. The special characteristic here is a conical step 34, whose transitions to the conical jacket face can be rounded. The advantages of such a variant can be better flow conditions and a lesser notch effect at the transition from the rivet shank 15 to the closing head 22. In such a design of the step 34 and with a clearance fit between the rivet shank 15 and the diameter of the upper, first hole segment 18, a centering action of the conical step 34 also occurs, which centers the excitation pole 11 relative to the outside diameter of the rivet shank 15 in the pole housing 10.

It will be clear that the joining method presented here by means of a rivet, preferably a blind rivet 13, is a very simple method of producing a durable positive and nonpositive connection between excitation poles 11 and a pole housing 10 using simple tools. Compared to the methods with a rivet shank formed from the excitation pole, higher clamping forces between the excitation pole and the pole housing are needed before the joining, and in addition stronger joining forces must be brought to bear.

In excitation poles 11 with a continuous hole 31, defective rivet connections can be undone as needed by drilling open the rivet 13 and remaking the connections by the method of the invention. Instead of blind rivets, simple rivets with a solid shank 15 can also be used, since the closing head 22 of such a rivet 13 can be made there by inserting a suitable riveting tool into the through hole 31.